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(54) Title of Invention: Exhaust Emission Control System for Variable Cylinder System Engines

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Specification

Title of Invention

Exhaust Emission Control System for Variable Cylinder System Engines

Claim(s)

An exhaust emission control system for a variable cylinder system engine comprised of a variable cylinder system control circuit that shuts off the fuel supply to at least one of the cylinder groups comprised of a specified number of cylinders depending on engine load; oxygen sensors and three-way catalysts that are provided in the exhaust passages of multiple cylinders belonging to the groups of multiple cylinders mentioned above to control the air-fuel ratio when the engine is operated under the partial cylinder mode; and an oxygen sensor and a three-way catalyst which are located in the merged section of the exhaust passages downstream of the exhaust passages mentioned above to control the air-fuel ratio when the engine is operated under the full cylinder mode; a unique feature of which is that the system is equipped with a switching device that switches the active cylinder group whenever the engine operating mode changes from full cylinder mode to partial cylinder mode.

Detailed Explanation of the Invention

This invention concerns the exhaust emission control system of variable cylinder system engines equipped with a variable cylinder control system that varies the number of cylinders to which fuel is supplied depending on engine load, and an air-fuel ratio control system for exhaust emission control, whereby the switching is made between the inactive cylinder group and the active cylinder group whenever the engine runs under full cylinder mode; the purpose of which is to improve the driving feeling.

In general, whenever an engine is operated under a heavily loaded condition, engine fuel economy tends to improve. This is the reason for the use of a variable cylinder system for a multiple cylinder engine. When it is operated under a light load condition, the fuel supply to a partial group of its cylinders is shut off so that the load for the remaining active cylinder group can be increased by the load corresponding to the inactive cylinders. This results in a relative increase in load per cylinder

leading to improvement in the overall fuel economy of the engine.

On the other hand, there is a system known as an engine exhaust emission control means in which a three-way catalyst is installed in the exhaust system, while the oxygen concentration of the exhaust gas is detected to achieve feedback control of the air-fuel ratio to become approximately equal to the stoichiometric air-fuel ratio, so that the three-way catalyst can perform oxidation of HC and CO as well as reduction of NOx at the same time with high efficiency. When this particular exhaust emission control system is applied to a variable cylinder system engine, especially under a partial cylinder mode when a partial group of its cylinders is made inactive, the oxygen concentration in the exhaust gas becomes excessively high and different from that in the actual active cylinders supplied with fuel. This results from air exhausted from the inactive cylinders without combustion, which forces the control to decrease the air-fuel ratio.

In order to circumvent this problem, oxygen sensors and 3-way catalysts are installed separately for the split exhaust passages, one for the active cylinder group and the other for the inactive cylinder group, so that the air-fuel ratio can be feedback-controlled independently of each other group of cylinders, while the feedback control can be stopped for the inactive cylinder group during the partial cylinder mode.

This system has the problem that the three-way catalyst in the inactive cylinder group is cooled during the partial cylinder mode by the exhaust air. When this partial cylinder mode is continued for a long time, the catalyst temperature becomes lower than the activation temperature needed for catalytic reaction, leading to a potential inability to achieve the required reaction efficiency when the engine running condition calls for the full cylinder mode.

In order to address this problem, the inactive cylinder group is alternated with the active cylinder group during engine operation, instead of being inactive all the time, in such a manner that the use frequency of the three-way catalyst is made to be equal between the active and inactive cylinder groups.

This method, however, requires frequent switching between the cylinder groups depending on the relationship with respect to the catalyst temperature, requiring switchovers even during the partial cylinder mode resulting in discontinuous combustion relative to the ignition sequence, which leads to a potential deteriorating driving feeling (shock generation) during the switchover period.

In order to address these problems, this invention is designed to improve the driving feeling of a variable cylinder system engine by installing oxygen sensors and three-way catalysts at the exhaust passages of the active cylinder group and in-active cylinder group, and installing a three-way catalyst and an oxygen sensor in the merged section of the exhaust passage downstream of the exhaust passages from the two groups of cylinders mentioned above. In this manner, even during the partial cylinder mode, the temperature of the three-way catalyst in the merged passage can be maintained at an acceptable degree even during the partial cylinder mode so that the switching between the inactive cylinder group and active cylinder group can be made when the engine operation is switched from the full cylinder mode, during which the driving feeling has not deteriorated, to the partial cylinder mode. Next, during the partial cylinder mode, the inactive cylinder group is switched to the active cylinder group. In this manner, the system invented herein can provide switching between the active and inactive cylinder groups in the multi-cylinder variable cylinder system engine that satisfies both the exhaust emission control performance and the smooth driving requirement.

Explained below using drawings are working examples of this invention.

In these working examples, an electronically controlled 6-cylinder fuel injection engine is used in which the number of fuel-supplied cylinders is controlled by the pattern indicated in Fig. 2.

In Fig. 1, 1 is the engine, 1a is the intake passage, 1b and 1c are the divided exhaust passages for cylinders $\phi 1$ -- $\phi 3$ and cylinders $\phi 4$ ~ $\phi 6$, respectively, and 1d is the merged exhaust passage of these two divided passages.

Located in exhaust passages 1b, 1c, and 1d are three-way catalysts, 2, 3, and 4, respectively, and oxygen sensors, 5, 6, and 7, respectively. The outputs from oxygen sensors 5 ~ 7 are, as indicated in Fig. 3, sent to a fuel injection control circuit (EGI circuit, hereafter), 11, through an air-fuel ratio control circuit, 17, from a switching circuit, 16, as the air-fuel ratio correction signal. As explained later, the air-fuel ratio of the air-fuel mixture supplied to the engine is feedback controlled to be approximately equal to the stoichiometric air-fuel ratio.

EGI circuit 11 described above outputs the fuel injection signal simultaneous with the engine rpm, having a pulse width corresponding essentially to the intake airflow that is based on outputs from engine intake air flow rate sensor 9 and engine speed sensor 10. This output signal is corrected by the

feedback signal, mentioned above, before it is supplied to fuel injection valve 13 for $\phi 1 - \phi 3$ cylinders and fuel injection valve 14 for $\phi 4 - \phi 6$ cylinders through the variable cylinder system control circuit (VCS circuit, hereafter), 12.

VCS circuit 12 mentioned above performs the control function, as indicated in Fig. 2, in such a manner that it selectively shuts off the fuel supply to cylinders $\phi 1 \sim \phi 3$ or to cylinders $\phi 4 \sim \phi 6$ under a light engine load condition, and supplies fuel to all cylinders (6 cylinders) under a heavy load condition. The status-quo region (in Fig. 2) represents the hysteresis region for preventing hunting during the period when the cylinder groups are switched over.

Based on the signal from the throttle switch, 8, the full cylinder mode restoration rpm is decreased from No to No' during the time the throttle valve is fully closed.

VCS circuit 12 is configured as that shown in Fig 4. In this figure, 25 and 26 pulse width comparators, which compare the output of comparison standard voltage generator 27 for a heavy load (P_{WH}) and the output of comparison standard voltage generator 28 for a light load (P_{WL}), with the output of the fuel injection pulse signal, P_W. If the latter is greater than the respective standard values, VCS circuit 12 outputs the high level signal, "1." A flip-flop, 33, permits input of the output of comparator 25 to the J-terminal, and input of the output of comparator 26 to the K -terminal through a sign inverter, 29, so that the sign of these outputs are changed. The number of cylinders is determined based on the output of flip-flop 33. In principle, output Q becomes "1" for the 6-cylinder signal when $P_W > P_{WH}$, and output $\bar{Q}$ becomes "1" for the 3-cylinder signal when $P_W < P_{WL}$.

A comparator, 31, to which the voltage, V_N, corresponding to the engine rpm is input through an F-V converter (frequency-voltage converter), 30, compares the V_N with output V_{NO} from the rpm standard voltage generator, 32. If it is found that $V_{NO} > V_N$, "1" is input to the S-terminal (set terminal) of flip-flop 33 so that output Q is restored to "1" for the 6-cylinder operation irrespective of pulse width P_W.

In addition, the rpm standard voltage generator 32, when the "fully closed" signal is input from throttle switch 8, switches its generated standard voltage from V_{NO} to V_{NO}' causing the rpm for the 6-cylinder restoration to decrease further.

Flip-flop 34 is designed to switch the inactive cylinder group over to the group consisting of $\phi 1 \sim \phi 3$ cylinders or to the group consisting of $\phi 4 \sim \phi 6$ cylinders every time the running condition becomes the

6-cylinder mode. Every time output Q of flip-flop 33 mentioned above becomes "1," outputs Q and $\bar{Q}$ are mutually inverted in such a manner that if one becomes "1," the other becomes "0." By forcing outputs Q and $\bar{Q}$ to be input to the "AND" circuits, 35 and 36, the group of inactive cylinders, for which the fuel supply is cut-off, is switched. When the output of $\bar{Q}$ of flip-flop 33 becomes "1," either outputs Q or $\bar{Q}$ of flip-flop 34, whichever outputs the signal "1," opens the gate. This leads to the sending of "1" for the 3-cylinder signal to the normally closed analog switches (normally closed relay), 37 or 38, to open the relay contact point.

Analog switch 37 is inserted into the circuit that provides the fuel injection signal to fuel injection valve 13 for $\phi1 \sim \phi3$ cylinders, while analog switch 38 is inserted into the circuit that provides the fuel injection signal to fuel injection valve 14 for $\phi4 \sim \phi6$ cylinders.

Consequently, since output $\bar{Q}$ of flip-flop 33 is "0," during the 6-cylinder operation, both analog switches 37 and 38 are in the state in which the relay contact points are closed. If, however, the 3-cylinder signal "1" is output as output Q, the relay contact point of either one of analog switches 37 or 38 is turned off, causing the operation of either the $\phi1 \sim \phi3$ cylinder group or the $\phi4 \sim \phi6$ cylinder group to become inactive.

As explained earlier, this switching is achieved only during the 6-cylinder operation because outputs Q and $\bar{Q}$ are inverted to open either one of the gates for the AND circuits 35 or 36 alternately every time flip-flop 34 inputs "1," which is the 6-cylinder signal for output Q of flip-flop 33 in the previous step.

Next, the variable cylinder system control signals, a and b, from VCS circuit 12 are input to a delay circuit, 15, depicted in Figs 3 and 5, to activate switching circuit 16 for the outputs of oxygen sensors 5 ~ 7.

Here, the normally closed analog switches (normally closed relays), 39 and 40, and 41 and 42, in switching circuit 16 are turned on when variable cylinder signals "a" and "b" become "1" (the exception being that switches 39 and 42 will be turned on when signals "a" and "b" become "0," because of the presence of sign inverters, 43 and 44.)

Consequently when the variable cylinder signals "a" and "b" mentioned above are input to switching circuit 16 through delay circuit 15 after a specified time delay, the output of oxygen sensor 5 or 7 is

selected corresponding to these signals before being input to comparator18 in air-fuel ratio control circuit 17.

Specifically, since variable cylinder signal "b" is "1" when cylinders $\phi 1 \sim \phi 3$ are inactive, analog switch 40 is turned off while switch 39 is turned on. At the same time, since variable cylinder signal "a" is "0," analog switch 41 is turned on and switch 42 is turned off, causing the output of oxygen sensor 5 to be selected to perform feedback control of the air-fuel ratio, which is explained later, for $\phi 4 \sim \phi 6$ cylinders.

Similarly when cylinders $\phi 4 \sim \phi 6$ are inactive, analog switches 40 and 41 are turned on to perform feedback control of the air-fuel ratio for cylinders $\phi 1 \sim \phi 3$ based on the output from oxygen sensor 6 for cylinders $\phi 1 \sim \phi 3$. During the full cylinder operation, only analog switch 42 is turned on to perform feedback control for all cylinders based on the output of oxygen sensor 7 located in merged passage 1d

The reason a specified time delay is provided for switching the outputs of oxygen sensors 5 ~ 7 is to take into consideration the time needed for the combustion gas to reach oxygen sensors 5 ~ 7 during the cylinder switching period. If switching circuit 16 is activated simultaneously with the cylinder switching, although momentarily, there is a possibility that the oxygen concentration of the exhaust gas from the inactive cylinders will be detected. This would lead to creating a potential risk of causing confusion in the feedback control as indicated earlier. The time delay assures that this problem will be prevented from occurring.

Next, air-fuel ratio control circuit 17 is designed to output an air-fuel ratio correction signal to EGI circuit 11 mentioned earlier based on the output of oxygen sensors 5 ~ 7 so that the feedback control is performed to obtain an air-fuel ratio close to the stoichiometric air-fuel ratio.

Number 19 represents a standard voltage generator that outputs the standard voltage corresponding to the stoichiometric air-fuel ratio, while number 18 is a comparator that compares this standard voltage with the output of the oxygen sensors mentioned above. Number 20 represents a correction circuit that outputs a correction signal based on deviation of the outputs of comparator 18 and the established standard signal. Number 22 represents, as described later, a clamp *(phon)* circuit to hold the output value at a constant value by interrupting the feedback control based on the outputs of monitor circuit

21 that determines the output condition of the oxygen sensors, and based on the full throttle signal from full throttle switch 24, or based on the fuel-cut signal during deceleration. In addition, monitor circuit 21 activates clamp circuit 22 to interrupt the feedback control as mentioned above when the temperatures of oxygen sensors 5~7 become too low to generate an appropriate output, or when the start signal is received from the starter switch, 23.

With the configuration explained above, when cylinders $\phi1 \sim \phi3$ are active, air-fuel ratio feedback control is performed based on the output of oxygen sensor 6, which permits fuel injection valve 13 to inject fuel so that an air-fuel mixture close to the stoichiometric value can be supplied to cylinders $\phi1 \sim \phi3$.

Consequently, three-way catalyst 3 can achieve high efficiency oxidation of HC and CO as well as reduction of NOx at the same time.

For the other three-way catalyst, 2, during this period, since the exhaust air from cylinders $\phi4 \sim \phi6$ is flowing into it, there is a possibility that its temperature might decrease. But, for three-way catalyst 4 located downstream, since the mixture of the combustion exhaust gas from cylinders $\phi1 \sim \phi3$ and the non-combustion exhaust gas from cylinders $\phi4 \sim \phi6$ is flowing into it, the temperature reduction will be relatively lower than that of three-way catalyst 3 located upstream. As a result, when the engine operation is shifted to the full cylinder mode, and even when the reaction of three-way catalyst 2 for cylinders $\phi4 \sim \phi6$ is low, three-way catalyst 4 in merged passage 1d can instantly achieve a highly efficient reaction.

Needless to say, feedback control of the air-fuel ratio can be achieved at the same time based on the output of oxygen sensor 7 located in merged passage 1d.

Moreover, since cylinder group switching is performed for every 6-cylinder operation, when it is followed by the 3-cylinder operation, the group consisting of cylinders $\phi4 \sim \phi6$, which has been inactive, becomes active while the group consisting of cylinders $\phi1 \sim \phi3$ becomes inactive.

Since cylinder group switching is performed in this manner, except when the partial cylinder operation lasts for a very long time, there is almost no possibility that the temperatures of upstream three-way catalysts 2 or 3 will decrease significantly.

Moreover, during the full cylinder operation, the purification (reaction) of harmful components in the exhaust gas takes place not only in downstream three-way catalyst 4, but also in upstream three-

way catalysts 2 and 3. This actually results in a marked decrease in the load on three-way catalyst 4, which permits decreasing the capacity of three-way catalyst 4.

Next, the working example shown in Fig. 6 is a system in which the generated voltage is switched by inputting variable cylinder signal "a" to standard voltage generator 19' in such a manner that the target air-fuel ratio for feedback control during the 3-cylinder operation is slightly lower than the stoichiometric air-fuel ratio.

In addition, the working example shown in Fig. 7 is a system in which upstream oxygen sensors 5 and 6 are eliminated, air-fuel ratio feedback control is interrupted during the 3-cylinder operation, and the specified air-fuel ratio is set at a value that is slightly lower than the stoichiometric air-fuel ratio. In order to achieve this control, the feedback control is interrupted and it is switched to a rich air-fuel ratio when variable cylinder control signal "a" is input to a clamp circuit, 22'.

In all of these working examples, the air fuel ratio is set slightly lower than the stoichiometric value to achieve NOx reduction efficiency of the upstream three-way catalysts 2 and 3 as high as possible during the 3-cylinder operation, while at the same time HC and CO can be oxidized under a sufficient amount of oxygen at three-way catalyst 4 in the merged passage, which leads to further improvement of exhaust emission control efficiency.

As explained above, according to this invention, it is no longer necessary to switch the cylinder groups during partial cylinder operation, which tends to worsen the driving feeling, resulting in improvement in driving performance. There is also another outstanding effect, thanks to the activity of the three-way catalyst placed in the merged exhaust passage, of preventing temporary deterioration of the exhaust characteristics that tend to occur when the engine operation is switched from the partial cylinder mode to the full cylinder mode.

Brief Explanation of Drawings

Fig. 1 is an approximate plan view of this invention. Fig. 2 explains the variable cylinder control pattern. Fig. 3 is a block diagram of the variable cylinder system for working example No 1, while Fig. 4 is a block diagram of its variable cylinder system circuit. Fig. 5 is a block diagram of the switching circuit. Figs. 6 and 7 are block diagrams of the control systems for other working examples

of this invention.

1. . . Engine Body

1b and 1c. . . Exhaust Passage

1d. . . Merged Exhaust Passage

2, 3, and 4. . . Three-Way Catalysts

5, 6, and 7. . . Oxygen Sensors

11. . . Fuel Injection Control Circuit

12. . . VCS Circuit

15. . . Delay Circuit

16. . . Switching Circuit

17. . . Air-Fuel Ratio Control Circuit

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FIGURES

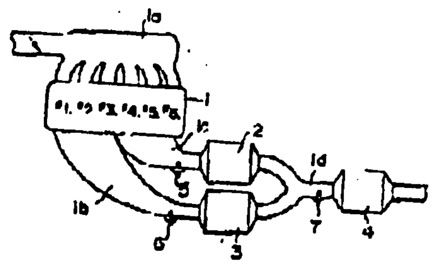

Fig. 1

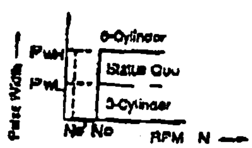

Fig. 2

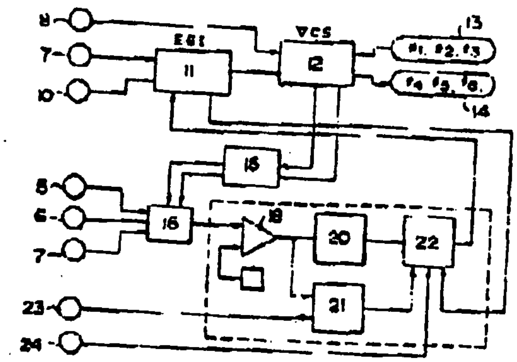

Fig. 3

FIGURES

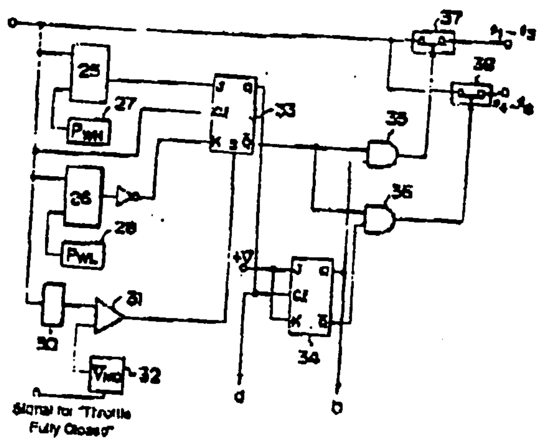

Fig. 4

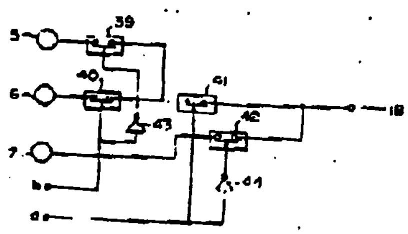

Fig. 5

FIGURES

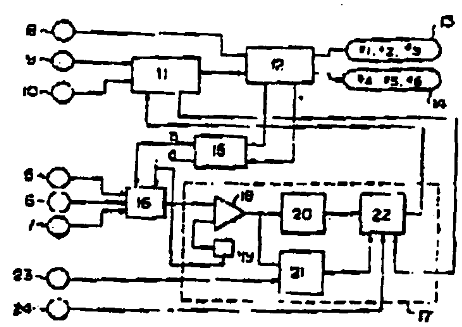

Fig. 6

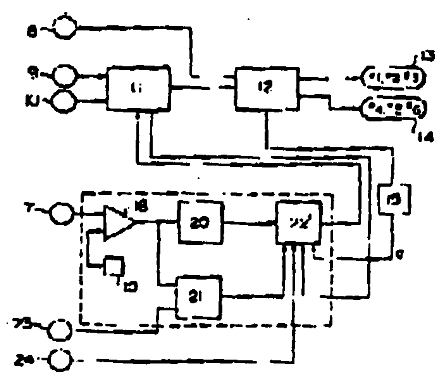

Fig. 7

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⑭気筒数制御エンジンの排気浄化装置

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明細書

発明の名称

気筒数制御エンジンの排気浄化装置

特許請求の範囲

予め定めた気筒の休止気筒グループの少なくとも1つへの燃料供給をエンジン負荷に応じて遮断する気筒数制御回路と、上記複数の気筒群グループの各々の排気通路に設け、混合気の空燃比を制御する酸素センサ及び三元触媒と、上記排気通路の下流の合流通路に設け、全気筒運転時に空燃比制御する酸素センサ及び三元触媒とを備えた多気筒エンジンにおいて、全気筒運転から部分気筒運転へ切換わるごとに稼働気筒グループを変える切換手段を設けたことを特徴とする気筒数制御エンジンの排気浄化装置。

発明の詳細な説明

本発明はエンジン負荷に応じて稼働気筒数を変化させるようにした気筒数制御機構と、排気浄化のための空燃比制御装置とを備えたエンジンにおいて、その切換ごとに休止気筒グループと稼働気筒グループの切換えを行うようにして運転フィーリングを向上させた気筒数制御エンジンの排気浄化装置に関するものである。

一般的にエンジンを高い負荷状態で運転すると、燃費率が良好となる傾向があり、このため、多気筒エンジンにおいてエンジン負荷の小さい状態で運転するときは、一部気筒グループに対する燃料の供給を停止することにより作動を休止し、その分だけ残りの稼働気筒グループの1気筒当りの負荷を相対的に高め、全体としての燃費の改善をはかるようにした気筒数制御エンジンが考えられた。

他方、エンジン排気対策の一手段として、排気系に三元触媒を設置するとともに、排気中の酸素濃度を検出して混合気を理論空燃比にフィードバック制御し、三元触媒によりHC、COの酸化とNO_xの還元とを同時に効率良く行うシステムが知られているが、このシステムを上記した気筒数制御エンジンに適用すると、とくに、一部気筒グループの作動を休止している部分気筒運転時に、

休止気筒からポンプ排出される空気により、排気中の酸素濃度が実際の運転気筒のガス組成成分と異って著しく高くなるため、空燃比を小さくするように制御してしまう。

このような不都合を避けるために、稼動気筒グループと休止気筒グループとに対応して分割した排気通路に、それぞれ酸素センサと三元触媒とを配置して、各々のグループで相互に独立的に空燃比のフィードバック制御を行うとともに、部分気筒運転時は休止気筒側のフィードバック制御を停止するシステムが考えられた。

しかし、この場合は休止気筒側の三元触媒が部分気筒運転時に、排出空気によって冷却されるため、このような運転状態が長時間にわたって継続的に行われると、触媒反応を維持するに必要な温度以下になってしまい、次の全気筒運転に切り換ったときに直ちに良好な浄化効率を得ることができなくなるおそれがある。

このため、従来は休止気筒グループを一方に固定したままとせず、エンジン運転中に稼動側

と休止側とを交互に振り分けて、三元触媒の使用頻度を両グループでほぼ同一となるようにしていた。

しかもこの振り分けは負荷状態との関係でかなり頻繁にしなければならないため、部分気筒運転中にでも振り分けを行うことがあり、この場合には点火順序の関係から不連続な燃焼が生じることがあり、振り分け時に運転フィーリングが悪化する（ショックを生じる）おそれがあった。

本発明はかかる点に鑑み、気筒数制御エンジンの運転フィーリングを向上するため稼動気筒と休止気筒との各排気通路に三元触媒と酸素センサを設置するとともに、その下流で合流する排気通路にも同様に三元触媒と酸素センサを設け、部分気筒運転時でも合流通路の三元触媒をある程度の温度に維持することにより、休止気筒グループと稼動気筒グループの切換えを、運転フィーリングの悪化しない全気筒運転から部分気筒運転へ切換わるごとに行い、次の部分気筒運転時には休止気筒グループと稼動気筒グループとを交代させるよう

にして、排気性能と運転性能とのいずれに対しても良好な得られる気筒数制御グループの切換えを可能とした装置を提供するものである。

以下、本発明の実施例を図面にもとづいて説明する。

本実施例では、第2図に示すようなパターンでもって稼動気筒数を制御する6気筒電子制御燃料噴射エンジンを例にして説明する。

第1図において、1はエンジン本体、1aは吸気通路、1b，1cはそれぞれ#1～#3気筒と#4～#6気筒とに対応して分割された排気通路、1dは両通路の合流排気通路を示す。

そして、排気通路1b～1dには、それぞれ三元触媒2，3及び4と、酸素センサ5，6及び7が設置される。酸素センサ5～7の出力は、第3図に示すように、切換回路15から空燃比制御回路17を介して燃料供給装置である燃料噴射制御回路（以下EGI回路と称する）11に、空燃比補正信号として送出され、後述するように、エンジン供給混合気の空燃比を理論空燃比にフィ

ードバック制御する。

上記EGI回路11はエンジン吸入空気量センサ9、エンジン回転数センサ10の出力にもとづいて、基本的には吸入空気量に応じたパルス巾をもちエンジン回転数に同期した燃料噴射信号を出力するが、この信号は上記した通りフィードバック信号により補正された上で、気筒数制御回路（以下VCS回路と称する）12を介して#1～#3気筒の燃料噴射弁13と、#4～#6気筒の燃料噴射弁14に供給される。

上記VCS回路12は第2図に示す制御パターンでもって、エンジン負荷の小さい領域では、#1～#3または#4～#6気筒に対する燃料供給を選択的にカットし、エンジン負荷の大きい領域とエンジン低速回転領域で全気筒（6気筒）運転を行わせるような制御を行う。なお、低速低負荷領域は気筒数切換時のハンチング防止のためのヒステリシスである。

またニュートラルスイッチ8からの信号により、ニュートラル位置時には空燃比補正用信号をNoから

N_0 へとさらに低下させる。

VCS回路13は具体的には第4図に示すように構成されている。25と26はパルス幅の比較器で、高負荷（P_{WH}）に対応した比較基準電圧発生器27と、低負荷（P_{WL}）に対応した比較基準電圧発生器28の出力と、燃料噴射パルス信号P_Wとを比較し、それぞれ基準値よりも大のときにハイレベル"1"を出力する。フリップフロップ33はJ端子に比較器25の出力が、またK端子に比較器26の出力を符号反転器29を介して反転された出力がそれぞれ入力し、このフリップフロップ33の出力にもとづいて気筒数が決定され、即ちして$P_W > P_{WH}$のときにQ出力が6気筒信号の"1"となり、また$P_W < P_{WL}$のときに$\bar{Q}$出力が3気筒信号の"1"となる。

また、F−Vコンバータ（周波数電圧変換器）30を介してエンジン回転数に対応した電圧V_Nが入力される比較器31は、回転数基準電圧発生器32からの出力V_{NO}と比較した上で、$V_{NO} > V_N$のときに"1"をフリップフロップ33のS端子（セ

ット端子）に入力して、パルス幅P_Wに関係なくQ出力を"1"にして6気筒運転に戻す。

なお、上記回転数基準電圧発生器32はスロットルスイッチ8からの全閉信号が入力すると、発生基準電圧がV_{NO}から$V_{NO'}$に切換わり、6気筒への復帰回転数をさらに低下させる。

フリップフロップ34は前記ホットドラム休止気筒グループを、#1〜#3と#4〜#6とに6気筒毎に切換えるもので、前記フリップフロップ33のQ出力が"1"になる毎に、フリップフロップ34のQ出力と$\bar{Q}$出力とが交互に反転して、一方が"1"のときに他方が"0"となる。そして、このQ出力と$\bar{Q}$出力とをアンド回路35と36へ入力させて、その出力で運転休止する気筒グループを切換えるものであり、フリップフロップ33の$\bar{Q}$出力が"1"の時にフリップフロップ34のQ出力、又は$\bar{Q}$出力のうちいずれか"1"を出力した方のゲートを開き、3気筒信号の"1"を常閉のアナログスイッチ（常閉リレー）37または38に供給してリレー接点を開く。

アナログスイッチ37は#1〜#3の燃料噴射弁12へ、またアナログスイッチ38は#4〜#6の燃料噴射弁14へ、それぞれ燃料噴射信号を供給する回路に挿入される。

したがって、6気筒運転中はフリップフロップ33の$\bar{Q}$出力が"0"のため、アナログスイッチ37，38は共にリレー接点を閉成した状態にあるが、Q出力として3気筒信号の"1"が出力されると、いずれか一方のアナログスイッチ37または38のリレー接点がオフとなり、#1〜#3または#4〜#6の気筒グループの作動が休止する。

ところで、この切換えは、既にも述べた通り、フリップフロップ34が前段のフリップフロップ33のQ出力の6気筒信号である"1"が入力する毎に、そのQ出力と$\bar{Q}$出力が反転してアンド回路35と36のいずれか一方を交互にゲートオープンするため、必ず6気筒運転中に行われるのである。

次に、このVCS回路13からの気筒数制御信号a，bは、第3図、第5図に示す選択回路15

に入力され、圧力センサ5〜7の出力の切換回路16を作動させる。

ここで、切換回路16の常閉アナログスイッチ（常閉リレー）39，40と41，42とは、それぞれ気筒数信号aとbとが"1"のときにスイッチオン（ただし符号反転器43と44があるため、スイッチ39と42は信号aとbが各々"0"のときがスイッチオン）となる。

したがって選択回路15を介して所定の時間遅れをもって、上記した気筒数信号a，bが切換回路16に入力すると、これに対応して圧力センサ5ないし7の出力が選択されて空燃比制御回路17の比較器18に入力されるのである。

具体的には#1〜#3気筒が休止しているときは、気筒数信号bは"1"のため、アナログスイッチ40がオフとなり、スイッチ39がオンとなるとともに、気筒数信号aが"0"のため、アナログスイッチ41がオンで、同じくスイッチ42がオフとなるから、圧力センサ7の出力が選び出されて、#4〜#6気筒において燃焼するように空燃

比のフィードバック制御が行われる。

以下同じように、#4～#6気筒が休止しているときは、アナログスイッチ40と41がオンによって、#1～#3気筒側の酸素センサ8の出力にもとづき、#1～#3気筒で空燃比のフィードバック制御が行われ、全気筒運転時はアナログスイッチ43のみがオンとなり、合流通路14の酸素センサ9の出力にもとづいて、全気筒に対してのフィードバック制御が行われる。

ところで、これら酸素センサ5～7の出力の切換えに所定の時間遅れをもたせたのは、気筒数切換後に実際の排気ガスが酸素センサ5～7へ到達するまでの時間的な遅れを考慮しているためである。気筒数切換えと同時に切換回路16を作動させると、短時間ではあるが、休止気筒の新気空気を検出してしまう可能性が強く、前述したようなフィードバック制御の誤差を招くおそれがあるので、これを確実に防止するようにした。

次に、空燃比制御回路17は、酸素センサ5～7の出力をもとにして、前記EGI回路11に対

する空燃比の補正信号を出力するもので、理論空燃比の混合気が得られるようにフィードバック制御を行う。

19は理論空燃比相当の基準電圧を出力する基準電圧発生器、18はこの基準電圧と酸素センサ出力を比較する比較器、また、20は比較器18の出力と設定基準信号との偏差にもとづく補正信号を出力する補正信号回路。22は後述するように酸素センサ出力状態を判別するモニター回路21の出力や、スロットルスイッチ24からのアイドルシグナル信号やあるいは減速時の燃料カット信号にもとづいてフィードバック制御を止めさせるように、出力値を一定値にホールドするクランプ回路。そしてモニター回路21は酸素センサ5～7の温度が低く適正な出力を生じないときや、スタータスイッチ23からのスタート信号を受けたときに、上記のようにフィードバック制御を停止させるように、クランプ回路22を作動させるのである。

以上のように構成してあるので、#1～#3気

筒が作動している場合には、酸素センサ8の出力に基づいて空燃比のフィードバック制御が行われるため、#1～#3気筒の燃料噴射弁13は理論空燃比の混合気が得られるように燃料を噴射する。

したがって、三元触媒3に効率よく反応してHC，COの酸化とNO_xの還元を同時に行う。

このとき、他方の三元触媒2については#4～#6気筒からの新鮮空気が流入しているため、温度低下を生じる可能性はあるが、その下流の三元触媒4については、#1～#3気筒側の排気ガスと、#4～#6の新鮮空気との混合ガスが流入するため、上流側の三元触媒2に比較して温度低下の割合が低く、この結果、次に全気筒運転に移行したときでも、#4～#6気筒の三元触媒2の反応が充分でなくても、合流通路14の三元触媒4は即座に効率よく反応することができる。

全気筒運転のときは合流通路14の酸素センサ9の出力にもとづいて空燃比のフィードバック制御が行われる。

そして、この6気筒運転ごとに気筒グループの切り換えが行われるため、次の3気筒運転を行うときは、前回休止側であった#4～#6気筒が稼動グループとなり、#1～#3気筒は運転を休止する。

したがって、このように気筒グループの切換えが行われるので、部分負荷運転が非常に長く継続する場合を除き、上流側の三元触媒2または3の温度が著しく低下するということは殆んどない。

なお、全気筒運転時は下流側の三元触媒4ばかりではなく、上流側の三元触媒2，3でも排気ガス成分の浄化（反応）が行われるので、相対的に下流の三元触媒4の負担は極めて少なく、したがってこの三元触媒4の容量を小さくすることができる。

次に第5図に示す実施例は、3気筒運転時にフィードバック制御の目標空燃比を理論空燃比よりも若干濃くするように、気筒数信号aを基準電圧発生器19に入力して、発生電圧を切り換えるものである。

また、第7図に示す実施例は、上流側の酸素センサ5,6を除去して、3気筒運転時は空燃比フィードバック制御を止めるとともに、設定空燃比を理論空燃比よりも若干濃く設定するようにした。この時の気筒数制御信号S_cがクランプ回路17に入力したときにフィードバックを停止して濃い空燃比に切換える。

これらいずれの実施例も、空燃比を若干濃くすることにより3気筒運転時に上流側三元触媒2,3でのNOxの還元効率を最大限に保つとともに、HC,COについては合流側の三元触媒4で酸素が十分に存在するもとで酸化させることにより、排気浄化効率を一層良好にするものである。

以上説明したように本発明によれば、過渡フィーリングを悪化させる部分気筒運転時に気筒数グループの組み合わせを行わなくてすみ、したがって運転性能が向上する一方、全気筒の三元触媒の働きにより部分気筒運転から全気筒運転に切換えたときに生じやすい排気特性の一時的な悪化を、確実に防止できるという優れた効果がある。

図面の簡単な説明

第1図は本発明の構成平面図、第2図は気筒数制御パターンを示す説明図、第3図は第1実施例の制御系のブロック図、第4図は気筒数制御回路のブロック図、第5図は切換回路のブロック図、第6図、第7図はそれぞれ他の実施例の制御系のブロック図である。

1…エンジン本体、1b,1c…排気通路、1d…合流部排気通路、2,3,4…三元触媒、5,6,7…酸素センサ、11…燃料噴射制御回路、12…気筒数制御回路、13…選択回路、16…切換回路、17…空燃比制御回路。

特許出願人　日産自動車株式会社

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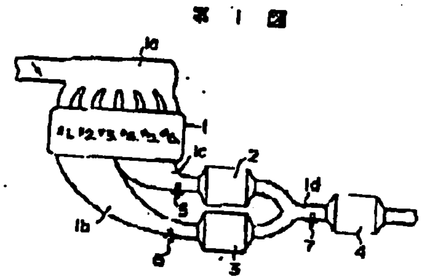
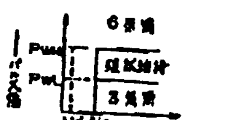
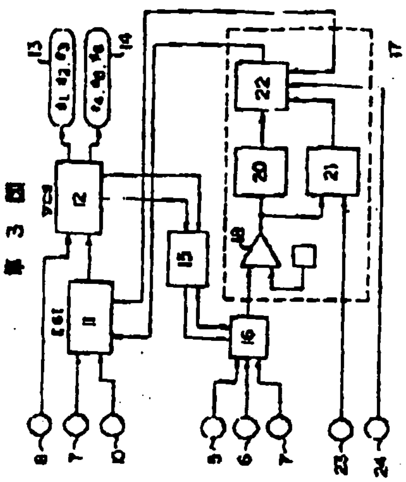
第1図



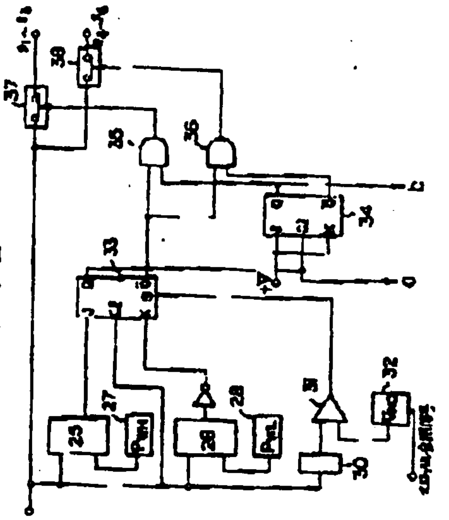
第2図



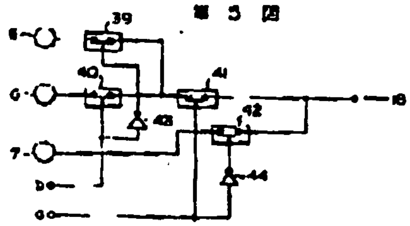
第3図



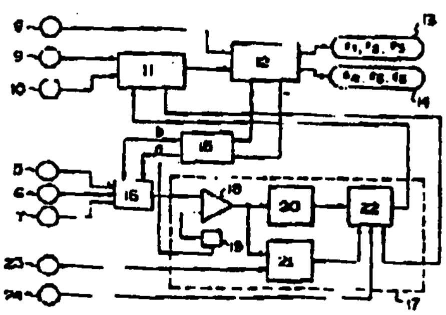
第4図



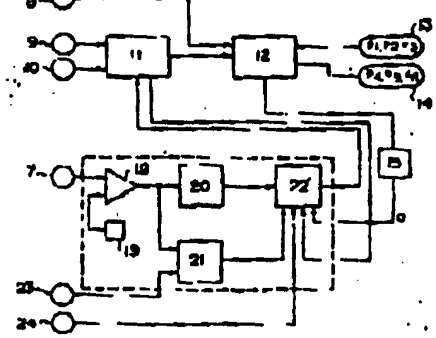
第5図



第6図



第7図



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